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USER'S MANUAL FOR THE DYNASPHERE SGEMP COMPUTER CODE.(U)

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IRT Corporation
P.O. Box 80817
San Diego, California 92138

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The DYNASPHERE computer code for solution of SGEMP problems in spherical geometry, including space-charge-limited currents, is described. Emphasis is given to details of employing the code in modeling problems. A brief overview of code capabilities is provided. Computer requirements are listed, input cards are described, and a sample problem provided. Code outputs and other variables are defined in a glossary.

CONTENTS

1. INTRODUCTION

The DYNASPHERE computer code for the solution of system-generated electromagnetic pulse (SGEMP) problems in spherical geometry is described in this report. Emphasis is given to the practical details necessary for the effective operation of the code. A brief description of the code is outlined, and then specifics such as computer requirements essential to its operation are discussed. Input card requirements are detailed, a sample problem is treated, and the code output interpreted. Many prominent code variables are defined in a glossary. All terms necessary to the effective application of DYNASPHERE to typical SGEMP calculations are defined. Detailed descriptions of physics and modeling, as well as code checkouts, are found in Reference 1.

1. T. N. Delmer et al., "SGEMP Phenomenology and Computer Code Development," DNA 3653F, November 11, 1974.

2. DYNASPHERE DESCRIPTION

DYNASHPERE treats the SGEMP two-dimensional problem for axisymmetric* electron emission from concentric perfectly-conducting spheres. Emission electron energy spectrum, pulse shape, and spatial distributions must be specified to the code. Maxwell's equations are solved to obtain fields which act on the electrons. The electron motion is treated by following particles of charge through the spatial grid. The calculation is self-consistent in that fields modify electron trajectories which, in turn, modify the fields.

Electron emission can occur from the inner or outer spheres, although presently the code will not emit from both spheres simultaneously. Energy spectra and spatial and angular distributions are arbitrary. The emission current pulse is specified with a trapezoidal shape, with arbitrary rise and fall times and pulse length. No time-retardation of the emission current is modeled. This can be a considerable deficiency for small ratios of pulse length to light times-of-flight across object dimensions, or in calculations where surface currents within the emission region are required (Ref. 2). Worst-case surface currents, generally located just outside the emission region, occur in situations where moderately long-duration pulses are coupled with simultaneous emission. Minor code modifications could be made to retard electron emission for very short-pulse problems.

Particles of charge representing large numbers of electrons are used to represent photo-electric emission from surfaces. These particles can be injected with discrete or random energy and angular distributions. Electron emission at discrete spatial positions are required presently.

The normal configuration used in the calculations consits of concentric cylinders, although an isolated sphere can be treated in the

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2. E. P. Wennas, S. Rogers, and A. J. Woods, "Sensitivity of SGEMP Response to Input Parameters," IEEE Trans. Nucl. Sci. NS-22, No. 6, December 1975.

*The axis-of-emission symmetry is defined by the direction of photon propagation.

quasi-static section of the code. DYNASPHERE performs the calculation for the electric and magnetic fields produced by the electrons using either the full Maxwell's equations or the quasi-static Green's function approach, depending on input options specified. The latter approach was employed in the forerunner code TSPHERE (Ref 1) due to its ease of implementation. The method is valid under conditions of long pulse rise times and low-energy electron spectra (Ref 3). It has been retained as a subset of the DYNASPHERE code, but is not discussed in detail here because of the former documentation. The full Maxwell's equation treatment permits calculation of late-time current ringing in the structure and provides generally more accurate results.

Spherical coordinates are employed for the spatial zoning in DYNASPHERE. Excellent resolution of the region surrounding spherical objects can be obtained conveniently with this coordinate system. Spatial zoning can be variable in the radial direction but must be azimuthally symmetric. Functions to specify radial zoning to the code are employed internally. Constant or variable zoning may be requested. In the latter case, sizes can vary only mildly (typically a factor of 2 increase from the inner sphere to the outer sphere) or rapidly (typically a factor of 15 increase from inner to outer sphere). Strong variations are generally employed for high space-charge-limited (SCL) conditions where resolution of large field and current gradients is required.

Forces acting on the particles representing photo-electrons are limited to electric fields only.

Two time steps are employed in dynamic cases. The Maxwell's equation time step, or "light time step," is determined automatically by the code. It satisfies the Courant stability criterion and is also an integer divisor of the particle or "electron time step." Thus, the field equations may be called several times for each particle position update. A minor code modification is necessary to specify any particular light-time step.

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3. E. P. Wenaas and A. J. Woods, "Comparisons of Quasi-Static and Fully Dynamic Solutions for Electromagnetic Field Calculations in a Cylindrical Cavity," IEEE Trans. Nucl. Sci. NS-21, No. 6, December 1974.

A convenient summary of the DYNASPHERE calculational sequence is found in the flow chart in Figure 1. Notice that electron-emission information is obtained from a separate source. Also, notice the optional electron-trajectory "movie" capability. These movies can be obtained by specifying an input option and saving the resulting particle information on tape for later treatment by the MOVIE code (Ref. 4).

4. A. J. Woods, T. N. Delmer, and M. A. Chipman, "The Arbitrary Body of Revolution Code (ABORC) for SGEMP/IEMP," INTEL-RT 8141-028, April 1976.

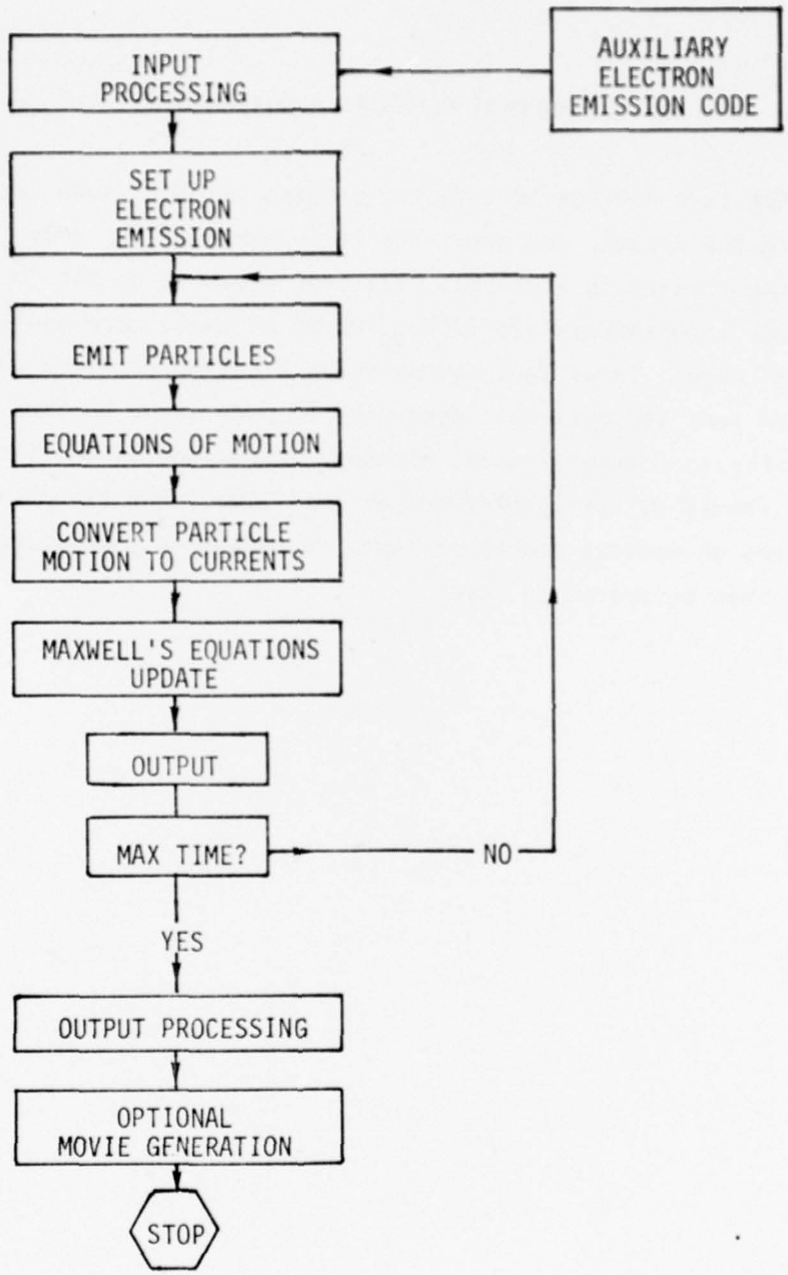

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Figure 1. DYNASPHERE flow chart

3. DYNASPHERE COMPUTER REQUIREMENTS

DYNASPHERE is a FORTRAN-IV computer program of about 4000 cards, including both the dynamic and quasi-static segments of the code. No machine language coding is employed. The code operates on the CDC 7600 computer. Core requirements are 42000_{10} words of small core and $100,000_{10}$ words of large core. Three fast-access files are also required during execution, and four are optional, depending on code input options chosen. The RUN compiler is currently used, although conversion to the faster FTN compiler should be straightforward at this time. Run times vary from 1 to 30 minutes of central processor time, depending on problem conditions. Core must be preset to zero.

4. DESCRIPTION OF THE INPUTS

Detailed descriptions of input quantities required by DYNASPHERE are listed in this section. Variable names and their physical or calculational significance are given, along with formats for reading them into the code.

A brief list of definitions peculiar to DYNASPHERE is given in Table 1. This information expedites communication of detailed code quantities. Variable limits are found in Table 2; these help the user to stay within the numerical and physical limitations of the code. The positions on the grid where quantities are evaluated are given in Table 3.

In addition to the detailed input descriptions listed here, the user will find a complete, abbreviated input description in the code listing itself. The descriptions are at the beginning of the main program (called MAIN). Once the programmer understands the basic functions of the inputs, the abbreviated manual is probably the most convenient to use. Also, certain variables are not defined in the input descriptions in this report because they pertain either to debugging the older quasi-static version of the code or to optional editing features. The abbreviated manual contains definitions of these quantities. These items can be ignored in standard SGEMP calculations.

Input card descriptions appear at the end of this section. The card numbers shown actually mean "card type". If an array requires more numbers than fit on one card, it is continued on the next card. An array, as opposed to a single variable, is identified quickly from the format information. A number appearing in front of the format type (A, E, or I) indicates an array, while lack of a number indicates a single value.

Variables may have more than one name. All names are given for convenience. The words "EDIT" and "DEBUG" appearing at the beginning of descriptions imply that the variable is used either for editing or for debugging purposes. These titles help the user to scan the descriptions more rapidly. The designations "MAX and "MAX NO" give the maximum value and the maximum number of values a variable can have, respectively. Minimum numbers of values are given by "MIN NO" where appropriate. Default values, set by the code when no value is read in, are also noted where applicable.

Table 1

DEFINITIONS OF TERMS COMMONLY USED IN THIS MANUAL AND IN DYNASPHERE OUTPUT

Particles	Large numbers of photo-electrons grouped into a single charged particle.
Mini-print	Short printout (3 lines) giving summary quantities helpful in analyzing the calculation. Can be printed out at times independent of the large 2-D prints.
2-D print	Large printout giving spatial distributions of fields and currents, as well as other pertinent information. Can be printed out less often than the small mini-prints.
Dynamic calculation	Indicates full Maxwell's equations solution for fields, as opposed to the quasi-static approximation.
Quasi-static calculation	Indicates fields calculated from Maxwell's equations with the time-derivative terms removed. Green's function technique is used.

Table 2

MINIMUM AND MAXIMUM VALUES OF DYNASPHERE VARIABLES

	Min. No.	Max. No.
Input Variables		
Zone number	3	50 radial, 20 angular: dynamic 20 radial, 20 angular: quasi-static
Time steps	-	-
Emission zones	1	50
Energy distributions	1	50[a]
Energy bins	1	50
Time histories	1	1
Angular distributions	1	50
Angular distribution bins		50
2-D prints	-	-
Mini-prints	-	-
Calculational Variables		
Total number of particles emitted in a given time step	0	2000
Number of particles being followed in a given time step	0	20000

[a]Only 1 angular and energy distribution per emission zone are permitted, however.

Table 3

RELATIVE POSITIONS ON GRID WHERE FIELDS, CURRENTS, AND CHARGES ARE CALCULATED

Positions c and b indicate zone center and boundary, respectively. These positions pertain to dynamic calculations only.

Quantity	Axial Position	Radial Position
E_r	c	b
E_Θ [(a)]	b	c
H_ϕ [(b)]	c	c
J_r	c	b
J_Θ	b	c
Charge in zone	b	b
Surface current	c	c

(a) Θ is the polar angle relative to the photon propagation direction

(b) ϕ is the azimuthal angle relative to the photon propagation direction

INPUT CARDS

Card Number	Columns (format)	Variable Name(s)	Description
1	1-78 (13A6)	TITLE	Comment card
2	1-2 (I2)	IOPT(1) (METHOD)	Quasi-static calculations only: gives Green's function source charge type 1 Source charges are rings 2 Source charges smeared out over spatial zone
2	3-4 (I2)	IOPT(2) (IRPINT)	EDIT: Limits printout -1 Minimum printout (no particle emission characteristics) 0 Particle emission characteristics 1 Green's function print if quasi-static
2	5-6 (I2)	IOPT(3) (INPUTR)	Determines emission particle initial radial positions in meters 0 Emit particles from radial position $r = 0.999*[RSAT - r_1/2)]$, dynamic $r = 0.999*RSAT$, quasi-static >0 Emit particles from radial position INPUTR (MAX ≤ outer sphere radius)
2	7-8 (I2)	IOPT(4) (ITDIM)	Do not execute problem of >0. Allows for stopping after Green's function calculation in quasi-static cases. Code does not read any information beyond the zoning cards (cards 5-8). Permits checkout of Green's function on various analytic charge densities. See IOPT(20).
2	9-10 (I2)	IOPT(5) (IDUMP)	DEBUG: Error off, to get core dump at end of problem if >0.
2	11-12 (I2)	IOPT(6) (IGRID)	Quasi-static only: 0 Source and field point grids are the same 1 Source and field point grids will be different

Card Number	Columns (format)	Variable Name(s)	Description
2	13-14 (I2)	IOPT(7) (IQSAT)	DEBUG: Permits Green's function checkout with no contribution from net charge on inner sphere
2	15-16 (I2)	IOPT(8)	DEBUG: Quasi-static only. A number of test problems to run checking out Green's function. If >1, code reads in IOPT(8)-1 new values for the variables IOPT(7,12, 13,14,20) in sequence after zoning cards (cards 5-8). Permits redefinition of various analytical charge densities. See IOPT(20) and also abbreviated user's manual in MAIN program.
2	43-44 (I2)	IOPT(22) (NESKIP)	Emit particles every NESKIP+1 time steps. Default = 0.
2	47-48 (I2)	IOPT(24) (NTSKIP)	Print out 2-D prints every IOPT(24) particle time steps. Overridden by DTPRNT (card 16).
2	40-50 (I2)	IOPT(24) (IEMIT)	0 Define emission particle angular bins relative to axis of coordinate system. 1 Define emission particle angular bins relative to surface normal.
2	51-52 (I2)	IOPT(26) (IOP26) (NEPTS)	Number of electron emission zones. If zero, emission zones same as angular zones defined by card 6, and cards 11 and 12 need not be read in. MAX = 50.
2	53-54 (I2)	IOPT(27) (NTH)	Number of emission electron angular lar bins. MAX = 50.
2	55-56 (I2)	IOPT(28) (NSPD)	Number of emission electron energy bins. MAX = 50.
2	57-58 (I2)	IOPT(29)	0 Quasi-static approximation. 1 Full Maxwell's equation treatment. -1 Quasi-static approximation with constant zone size in both radial and angular directions. Do not read in cards 5-8.

Card Number	Columns (format)	Variable Name(s)	Description
2	59-60 (I2)	IOPT(30) (IPRNT)	EDIT: Printout limiter in dynamic cases only. 0 Short print - does not print out surface current and charge density on outer sphere, nor photo-electron charge density in 2-D prints 1 Long print - prints out surface currents and charge densities on outer sphere as well as photo-electron charge density in 2-D print. Also prints out several other arrays such as charge in each zone as well as current densities calculated in a manner different from the Maxwell's equation section.
2	61-62 (I2)	IOPT(31)	Print mini-prints every IOPT(31) particle time steps. DEFAULT = 1.
2	63-64 (I2)	IOPT(32)	MOVIE option: Write particle position information to file TAPE20 every IOPT(32) particle time steps if >0. If <0, plot particle positions on printer as well as writing file.
3	1-2 (I2)	KOPT(1) (NR)	Number of radial zones MIN = 3 MAX = 50
3	3-4 (I2)	KOPT(2) (NT)	Number of angular zones MIN = 3 MAX = 20
3	5-6 (I3)	KOPT(3) (NC)	Use in quasi-static cases only 0 Radial source point zoning in Green's function same as field point zoning >0 Number of radial zones for sources for fields in Green's function. See IGRID [IOPT(6)]. MAX = 20
3	7-8 (I2)	KOPT(4) (NA)	Like KOPT(3) but for angular zones. MAX = 20

Card Number	Columns (format)	Variable Name(s)	Description
3	9-10 (I2)	KOPT(5)	EDIT: 2-D print size limiter. 0 Print out approximately 10 radial zones in 2-D prints in addition to special zones specified by KOPT(7 and 8) >0 Print out every KOPT(5) radial zones where indices are between the values specified by KOPT(7 and 8). DEFAULT = 1.
3	11-12 (I2)	KOPT(6)	EDIT: Print out every KOPT(6) angular zones. DEFAULT = printout ≤ 10 angles.
3	13-14 (I2)	KOPT(7)	Print every radial zone up to and including zone number KOPT(7) regardless of KOPT(5). DEFAULT = 1.
3	15-16 (I2)	KOPT(8)	EDIT: Print out every radial zone with index ≥ KOPT(8) regardless of KOPT(5). DEFAULT = number of radial zones
3	17-18 (I2)	KOPT(9)	Radial zoning flag - dynamic calculations only. 0 Constant zone size. 1 DEBUG: Sets constant zone size but uses FUNQR subroutine. Permits checkout of that routine when compared with same calculation with KOPT(9) = 0. 2 Zone size increases slowly to about twice as much at outer sphere as at inner sphere. 3 Zone size increases rapidly to about 10 times as large at outer sphere as at inner sphere.
3	19-20 (I2)	KOPT(10)	Random emission flag: 0 Discrete emission. >0 Randomize energy and angle of emission particles between bin centers defined by cards 9, 10, 13, 14. Requires at least 2 bins for energy spectra, 2 for angular distributions. Different values of KOPT(10) give different random number sequences.

Card Number	Columns (format)	Variable Name(s)	Description
3	21-22 (I2)	KOPT(11)	If >0, write current densities in radial and angular directions to file TAPE21 every particle time step. Permits use by lumped-element modeling code, which generates time histories of the currents.
3	23-24 (I2)	KOPT(12)	Check for more than 1 input deck if >0.
4	1-12 (E12)	RSAT	Radius of inner sphere (m)
4	13-24 (E12)	B	Radius of outer sphere. For quasi-static calculations with single sphere only, set RSAT $>10^4$ (m)
5	1-72 (6E12)	CI	Radial zone boundaries. Read in for quasi-static cases only (m). MAX NO = 20
6	1-72 (6E12)	ALPHA	Angular zone boundaries. Read in for quasi-static cases only (radians). MAX NO = 20.
7	1-72 (6E12)	RI	Radial zone boundaries for source charges in Green's function. Read in in quasi-static cases only (m). MAX NO = 20.
8	1-72 (6E12)	THETA	Angular zone boundaries for source charges in Green's function. Read in in quasi-static cases only (radians). MAX NO = 20.
9	1-72 (6E12)	ENRG	Initial energies of emission electrons. Read in IOPT(28) values (keV). MAX NO = 50.
10	1-72	THETA0	THETA-"ZERO": Initial directions of emission electrons at each emission point. Measured from surface normal or z axis, depending on IOPT(25). MAX NO = 50.

Card Number	Columns (format)	Variable Name(s)	Description
11	1-72 (6E12)	THP	Angular positions of emission points measured from axis of the coordinate system. Read in IOPT(26) values only if IOPT(26) >0 (radians). MAX NO = 50.
12	1-72 (6E12)	DTH	Width of the emitting sectors in units of cosine(min) - cosine(max) where min and max can be thought of as the minimum and maximum angular positions of the emission zone edges. Not a convenient input. See IOPT(26) for easier-to-use method. Read in IOPT(26) values if IOPT(26) >0. (dimensionless) MAX NO = 50.
13	1-72 (6E12)	FNORMS	Normalizing factor for emission current density from each emission zone. Multiplies JPEAK. Negative value means use the energy and angular distributions from the previous emission zone (1 zone closer to the axis). Read in IOPT(26) values (dimensionless)
14	1-72 (6E12)	ELN	Relative number intensity of electrons in each energy group. Read in as many cards 14 and 15 in pairs as there are positive values of FNORMS (card 13). Code normalizes spectra to JPEAK peak emission current density. Beware of these units. (electrons/energy bin) MAX NO = 50.
15	1-72 (6E12)	FTH	Relative number intensity of emission electrons in each emission angular distribution bin. See also card 14. All distributions normalized by code to peak emission current density of JPEAK. Beware of these units. (electrons/angular bin) MAX NO = 50
16	1-12 (E12)	TMAX	Maximum time of calculation (nsec)

Card Number	Columns (format)	Variable Name(s)	Description
16	13-24 (E12)	DELT	Particle time step (nsec)
16	25-36 (E12)	T1	Rise time of the trapezoidal emission current pulse (nsec)
16	37-48 (E12)	T2	Emission current pulse is constant from T1 to T2 (nsec)
16	49-60 (E12)	T3	Emission current pulse falls off linearly to zero from T2 to T3 (nsec)
16	61-72 (E12)	DTPRNT	Print 2-D prints every DTPRNT nsec
17	1-12 (E12)	NTOT	Total number of electrons emitted in the emission current pulse. If zero, calculated from JPEAK (card 17). (electrons)
17	13-24 (E12)	JPEAK	Peak emission current density. If zero, calculated from NTOT (card 17). Either NTOT or JPEAK must be non-zero. (amp/m^2)
17	25-36 (E12)	TSTART	Quasi-static calculations only: Restart from dump tape at time $\gtrsim$ TSTART. See IOPT(17). (nsec)
17	37-48 (E12)	DTTAPE	Quasi-static calculations only: Write dump tape every DTTAPE nsec. See IOPT(18).

5. DYNASHPERE SAMPLE PROBLEM

A sample calculation is described in this section. The physical problem is described, and the required input cards are given. Selected code outputs are listed. Descriptions of these outputs are found in the variable glossary of Section 6.

This sample problem is sufficient to illustrate many code features and to provide a test of DYNASPHERE when it is converted to a different computer system.

The sample problem consists of a sphere of 2.3 m radius enclosed in an outer sphere of 15.2 m radius. Mono-energetic electrons of energy 7.1 keV are emitted uniformly from one-half the inner sphere surface. The pulse shape is trapezoidal, with 45 nsec rise and fall times and 55 nsec full-width-at-half-maximum. The peak emission current density is 0.108 amp/m^2, and the electrons are assumed to be emitted radially outward.

The problem conditions result in a non-space-charge-limited solution. Gradients will not be steep, and the slowly varying radial zone size is sufficient to give reasonably accurate resolution of gradients near the inner sphere. KOPT(9) is set to 2, and 30 radial zones are used, resulting in a minimum radial zone size of 0.24 m (chosen by the code). A time step of 2.5 nsec causes particles to traverse about one-half this distance each step. Ten angular zones and five emission zones are employed, with the latter being set by the code. The problem is run to 150 nsec, with large spatial printouts every 20 nsec. Particles are emitted every other time step.

The particular model chosen for this sample problem should not be regarded as a typical SGEMP problem. Simplifying assumptions, such as monoenergetic electron emission normal to the surface, may give unrealistic results, and the practice of emitting particles every other time step can be particularly dangerous in space-charge-limited situations. These simplifying assumptions were adequate for the purposes of this sample problem, however.

Input card images describing the sample problem to the code are shown in Figure 2. The particle emission characteristics resulting from the electron emission specifications are shown in Figure 3. These variables give initial electron positions, energies, and angles. A sample mini-print and a sample spatial print appear in Figures 4 and 5, for a time of 20 nsec. Limited information on fields, currents, particle positions, etc., is given in the mini-print, while detailed spatial distributions are contained in the larger print. Note that only 12 of the 30 radial zones are printed out in the spatial distribution of fields and currents. All 30 zones could have been obtained by setting KOPT(5) = 1.

A slightly low value for the quantity QINJEK (total emitted charge) will be seen in the mini-print. The number shown is about 25 percent lower than the time integral of the emission current. This is a consequence of choosing a large time step and emitting particles every other step (a procedure that is not recommended). By the end of the pulse, the emitted charge is much more consistent with the expected value.


```
DYNASPHERE,MINI COMP.,LO FLG, 30X10, VAR DR
02000000000000100-101012201140016001819000 1002001 0010101 0 1 0 000012001 01101
3010 0 0 0 0 3 0 2    1
2,3          15,2
7,1
0,
1,           -1.          -1.          -1.          -1.          0.
0,           0.           0.
1,
1,
150,         2.5          45.          55.          100.         20.
0.           .108
```

Figure 2. DYNASPHERE sample problem input deck

```
******************** CHARACTERISTICS OF A BUNDLE OF PARTICLES ********

R         (METERS)    0                                 5 VALUES

   2.1790E+00   2.1790E+00   2.1790E+00   2.1790E+00   2.1790E+00

THETA     (RADIAN)    0                                 5 VALUES

   1.5708E-01   4.7124E-01   7.8540E-01   1.0996E+00   1.4137E+00

VR        (M/SEC )    0                                 5 VALUES

   4.9462E+07   4.9462E+07   4.9462E+07   4.9462E+07   4.9462E+07

VTHETA    (M/SEC )    0                                 5 VALUES

   0.           0.           0.           0.           0.

EMQ       (COULS.)    0                                 5 VALUES

   8.6729E-09   2.5170E-08   3.9203E-08   4.9398E-08   5.4758E-08

ENERGY    ( KEV. )    0                                 5 VALUES

   7.1000E+00   7.1000E+00   7.1000E+00   7.1000E+00   7.1000E+00

SPEEDS    (M/SEC )    0                                 5 VALUES

   4.9462E+07   4.9462E+07   4.9462E+07   4.9462E+07   4.9462E+07
```

Figure 3. DYNASPHERE particle emission characteristics printout sample

```
ITIME,T,JNOW,JNET,Q:INJEK,LEAVE,BACK,NET       8     2.0000E+01    0.       0.       1.2529E-08   0.   0.   1.2529E-08
ER(0,90DEG) -2.8915E+01 -1.9698E+01 SURFCUR (45,90,135DEG) -2.2220E-02 -1.2394E-01 -2.2148E-02 NPART   20   20
R 1-5   16-    20  3.1682E+00 3.1682E+00 3.1682E+00 3.1682E+00 3.1682E+00 2.4262E+00 2.4262E+00 2.4262E+00 2.4262E+00 2.4262E+00
```

Figure 4. DYNASPHERE mini-print example for time of 20 nsec

T.ITIME.NLEAVE.NRET.NBACK.NBANK.NPART .20000E+02 6 0 0 0 0 20

MAX NO. OF PARTICLES UP TO THIS TIME IS 20

QBACK (COULS.) 8 30 VALUES

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

FBACK (FRACT.) 9 30 VALUES

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

QNET (COULS.) 4 10 VALUES

6.1323E-10	1.7747E-09	2.7719E-09	3.4924E-09	3.8718E-09	0.	0.	0.	0.	0.

THE E FIELDS IN THE R DIRECTION ARE

THETA(RAD)	0.	3.1416E-01	6.2832E-01	9.4248E-01	1.2566E+00	1.5708E+00	1.8850E+00	2.1991E+00	2.5133E+00	2.8274E+00
R(M)										
2.4236E+00	2.912E+01	2.871E+01	2.822E+01	2.720E+01	2.475E+01	1.445E+01	4.554E+00	2.098E+00	[illegible]	[illegible]
2.6770E+00	1.128E+01	1.107E+01	1.070E+01	9.364E+00	8.461E+00	6.766E+00	3.072E+00	1.565E+00	8.456E-01	4.67[illegible]E-01
2.9431E+00	2.616E+00	2.512E+00	2.238E+00	1.718E+00	9.502E-01	1.427E+00	1.403E+00	1.138E+00	6.179E-01	3.447E-01
3.8170E+00	-7.128E-02	-1.067E-01	-2.009E-01	-3.457E-01	-4.328E-01	6.164E-06	4.330E-01	3.462E-01	2.016E-01	1.063E-01
4.8043E+00	-1.244E-02	-2.091E-02	-4.369E-02	-8.459E-02	-1.004E-01	1.260E-05	1.004E-01	8.471E-02	4.410E-02	2.071E-02
5.9052E+00	-9.480E-04	-1.450E-03	-5.854E-03	-1.280E-02	-1.454E-02	4.354E-07	1.460E-02	1.282E-02	5.890E-03	[illegible]
7.1195E+00	-5.468E-05	-2.451E-05	-1.522E-04	-6.444E-04	-1.350E-03	2.138E-08	[illegible]	6.491E-04	1.567E-04	2.223E-05
8.4473E+00	-4.656E-07	5.880E-09	-4.858E-07	-3.251E-06	-1.111E-05	1.507E-10	1.111E-05	3.253E-06	6.067E-07	[illegible]
9.8887E+00	-5.650E-10	7.402E-11	-2.878E-10	-2.732E-09	-1.304E-08	1.801E-11	1.304E-08	2.734E-09	[illegible]	[illegible]
1.1443E+01	-1.377E-13	2.523E-14	-3.430E-14	-4.663E-13	-3.092E-12	4.437E-17	[illegible]	4.441E-13	3.777E-14	[illegible]
1.3112E+01	-7.017E-18	1.471E-18	-8.326E-19	-1.675E-17	-1.542E-16	2.245E-21	1.542E-16	1.676E-17	[illegible]	[illegible]
1.4894E+01	-7.868E-23	1.767E-23	-4.312E-24	-1.317E-22	-1.702E-21	[illegible]	1.702E-21	1.317E-22	[illegible]	[illegible]

THETA(RAD)	3.1416E+00
R(M)	
2.4236E+00	3.746E-01
2.6770E+00	2.863E-01
2.9431E+00	2.076E-01
3.8170E+00	5.857E-02
4.8043E+00	9.547E-03
5.9052E+00	5.462E-04
7.1195E+00	4.928E-06
8.4473E+00	7.705E-09
9.8887E+00	2.409E-12
1.1443E+01	1.499E-16
1.3112E+01	1.919E-21
1.4894E+01	5.272E-27

Figure 5. DYNASPHERE spatial print example

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THE E FIELDS IN THE [illegible] DIRECTION ARE

THETA(RAD)	1.5708E-01	4.7124E-01	7.8540E-01	1.0996E+00	1.4137E+00	1.7279E+00	2.0420E+00	2.3562E+00	2.6704E+00	[illegible]
R(M)										
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2.5472E+00	-8.591E-02	[illegible]	-2.046E-01	[illegible]	-2.747E+00	-2.747E+00	[illegible]	[illegible]	[illegible]	[illegible]
2.8069E+00	-1.014E-01	-1.292E-01	-3.023E-01	[illegible]	-2.971E+00	-2.971E+00	[illegible]	-3.011E-01	[illegible]	[illegible]
3.6619E+00	-5.516E-02	-1.106E-01	-2.582E-01	[illegible]	-1.184E+00	-1.184E+00	-5.777E-01	-2.572E-01	[illegible]	[illegible]
4.6303E+00	-1.729E-02	-4.363E-02	-1.157E-01	-2.493E-01	-3.825E-01	-3.824E-01	-2.431E-01	-1.151E-01	[illegible]	[illegible]
5.7122E+00	-3.234E-03	-4.319E-03	-2.710E-02	[illegible]	-1.062E-01	-1.062E-01	-5.454E-02	-2.647E-02	[illegible]	[illegible]
6.9077E+00	-2.355E-04	-4.635E-04	-2.298E-03	[illegible]	-1.863E-02	-1.863E-02	[illegible]	-2.283E-03	[illegible]	[illegible]
8.2166E+00	-6.447E-06	-2.973E-06	-1.746E-05	-1.117E-04	-4.019E-04	-4.019E-04	-1.116E-04	-1.734E-05	[illegible]	[illegible]
9.6390E+00	-1.675E-08	-3.494E-09	-2.055E-08	-1.836E-07	-9.187E-07	-9.187E-07	-1.835E-07	-2.039E-08	[illegible]	[illegible]
1.1175E+01	-7.799E-12	-8.943E-13	-4.742E-12	[illegible]	-3.929E-10	-3.929E-10	-5.837E-11	-4.705E-12	[illegible]	[illegible]
1.2824E+01	-7.359E-16	-5.089E-17	-2.204E-15	-3.779E-15	-3.476E-14	-3.476E-14	-3.779E-15	[illegible]	[illegible]	[illegible]
1.4587E+01	-1.457E-20	-6.522E-22	-2.158E-21	[illegible]	-6.568E-19	[illegible]	[illegible]	-2.140E-21	[illegible]	[illegible]
1.5200E+01	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

THE H FIELDS IN THE [illegible] DIRECTION ARE

THETA(RAD)	1.5708E-01	4.7124E-01	7.8540E-01	1.0996E+00	1.4137E+00	1.7279E+00	2.0420E+00	2.3562E+00	2.6704E+00	2.9845E+00
R(M)										
2.4236E+00	-5.639E-04	-1.046E-03	-2.174E-03	-4.210E-03	-6.684E-03	-6.683E-03	-4.207E-03	-2.167E-03	[illegible]	-4.740E-04
2.6770E+00	-4.777E-04	-9.078E-04	-1.895E-03	-3.645E-03	-7.148E-03	-7.148E-03	-3.643E-03	-1.889E-03	[illegible]	-4.084E-04
2.9431E+00	-3.853E-04	-7.621E-04	-1.597E-03	-3.047E-03	-5.517E-03	-5.517E-03	-3.045E-03	-1.591E-03	-7.448E-04	-3.341E-04
3.8170E+00	-1.644E-04	-3.665E-04	-7.962E-04	-1.491E-03	-2.368E-03	-2.367E-03	-1.440E-03	-7.954E-04	-3.608E-04	-1.444E-04
4.8043E+00	-4.378E-05	-1.152E-04	-2.947E-04	-6.114E-04	-8.382E-04	-8.382E-04	-6.113E-04	-2.934E-04	-1.124E-04	-4.150E-05
5.9052E+00	-6.380E-06	-2.088E-05	-6.335E-05	-1.322E-04	-2.143E-04	-2.142E-04	-1.321E-04	-6.304E-05	-2.031E-05	-5.057E-06
7.1195E+00	-4.588E-07	-7.813E-07	-3.977E-06	-1.604E-05	-3.581E-05	-3.581E-05	-1.604E-05	-3.951E-06	-6.651E-07	[illegible]
8.4473E+00	-9.255E-09	-3.975E-09	-2.344E-08	-1.540E-07	-5.649E-07	-5.699E-07	-1.540E-07	-2.327E-08	-2.517E-09	-2.425E-10
9.8887E+00	-1.944E-11	-3.878E-12	-2.272E-11	-2.075E-10	-1.060E-09	-1.060E-09	-2.076E-10	-2.255E-11	-1.760E-12	[illegible]
1.1443E+01	-7.591E-15	-8.383E-16	-4.395E-15	-5.535E-14	-3.805E-13	-3.805E-13	-5.535E-14	-4.361E-15	-2.446E-16	-1.215E-17
1.3112E+01	-6.085E-19	-4.086E-20	-1.743E-19	-3.051E-18	-2.864E-17	-2.864E-17	-3.051E-18	-1.724E-19	-6.412E-21	-2.455E-22
1.4894E+01	-1.062E-23	-4.636E-25	-1.507E-24	-3.688E-23	-4.777E-22	-4.776E-22	-3.684E-23	-1.495E-24	-4.260E-26	-1.066E-27

CURRENTS IN THE [illegible] DIRECTION

THETA(RAD)	0.	3.1416E-01	6.2832E-01	9.4248E-01	1.2566E+00	1.5708E+00	1.8850E+00	2.1991E+00	2.5133E+00	2.8274E+00
R(M)										
2.4236E+00	-3.183E-02	-3.144E-02	-3.144E-02	-3.144E-02	-3.144E-02	-1.572E-02	0.	0.	0.	0.
2.6770E+00	-1.790E-02	-1.768E-02	-1.768E-02	-1.768E-02	-1.768E-02	-8.843E-03	0.	0.	0.	0.
2.9431E+00	-7.361E-03	-7.270E-03	-7.270E-03	-7.270E-03	-7.271E-03	-3.635E-03	0.	0.	0.	0.
3.8170E+00	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4.8043E+00	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
5.9052E+00	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
7.1195E+00	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
8.4473E+00	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
9.8887E+00	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.1443E+01	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.3112E+01	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.4894E+01	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

Figure 5 (cont.)

THETA(RAD)	3.1416E+00
R(M)	
2.4236E+00	0.
2.6770E+00	0.
2.9431E+00	0.
3.8170E+00	0.
4.8043E+00	0.
5.9052E+00	0.
7.1195E+00	0.
8.4473E+00	0.
9.8887E+00	0.
1.1443E+01	0.
1.3112E+01	0.
1.4894E+01	0.

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CURRENTS IN THE Q2 DIRECTION

THETA(RAD)	1.5708E-01	4.7124E-01	7.8540E-01	1.0996E+00	1.4137E+00	1.7279E+00	2.0420E+00	2.3562E+00	2.6704E+00	2.9845E+00
R(M)										
0.	-1.985E-09	-8.293E-11	3.832E-10	-1.456E-07	-7.601E-08	0.	0.	0.	0.	0.
2.5472E+00	-6.319E-09	-4.113E-09	-1.119E-08	-3.935E-08	-2.490E-07	0.	0.	0.	0.	0.
2.8069E+00	-6.256E-09	-4.998E-09	-1.440E-08	-4.928E-08	-2.512E-07	0.	0.	0.	0.	0.
3.6619E+00	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4.6303E+00	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
5.7122E+00	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6.9077E+00	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
8.2166E+00	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
9.6390E+00	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.1175E+01	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.2824E+01	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.4587E+01	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.5200E+01	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

SURFACE CURRENTS IN THE Q2 DIRECTION

Q1=. -1.9049E+01

Q2	
1.5708E-01	-1.3424E-03
4.7124E-01	-7.2245E-03
7.8540E-01	-2.3348E-02
1.0996E+00	-5.7081E-02
1.4137E+00	-1.3052E-01
1.7279E+00	-1.3051E-01
2.0420E+00	-5.7045E-02
2.3562E+00	-2.3323E-02
2.6704E+00	-7.1034E-03
2.9845E+00	-1.1284E-03

SURFACE CHARGE DENSITIES

Q1=. -1.9049E+01

Q2	
0.	2.3351E-10
3.1416E-01	9.0962E-10
6.2832E-01	1.7007E-09
9.4248E-01	2.2563E-09
1.2566E+00	2.4128E-09
1.5708E+00	1.5020E-09
1.8850E+00	4.4408E-10
2.1991E+00	1.7406E-10
2.5133E+00	6.5271E-11
2.8274E+00	1.9229E-11
3.1416E+00	3.0041E-12

Figure 5 (cont.)

QIN (COULS.) 8 30 VALUES

5.2940E-23	5.2940E-23	5.2940E-23	5.2940E-23	5.2940E-23	5.2940E-23	5.2940E-23	5.2940E-23	5.2940E-23	5.2940E-23
5.2940E-23	5.2940E-23	5.2940E-23	5.2940E-23	5.2940E-23	5.2940E-23	5.2940E-23	5.2940E-23	5.2940E-23	5.2940E-23
5.2940E-23	5.2940E-23	5.2940E-23	5.2940E-23	5.2940E-23	5.2940E-23	5.2940E-23	5.2940E-23	5.2940E-23	5.2940E-23

QIN/QS (FRACT.) 8 30 VALUES

4.2252E-15	4.2252E-15	4.2252E-15	4.2252E-15	4.2252E-15	4.2252E-15	4.2252E-15	4.2252E-15	4.2252E-15	4.2252E-15
4.2252E-15	4.2252E-15	4.2252E-15	4.2252E-15	4.2252E-15	4.2252E-15	4.2252E-15	4.2252E-15	4.2252E-15	4.2252E-15
4.2252E-15	4.2252E-15	4.2252E-15	4.2252E-15	4.2252E-15	4.2252E-15	4.2252E-15	4.2252E-15	4.2252E-15	4.2252E-15

POTENTIALS AT THE INNER BOUNDARIES OF THE ZONES

THETA(RAD)	3.1416E-01	6.2832E-01	9.4248E-01	1.2566E+00	1.5708E+00	1.8850E+00	2.1991E+00	2.5133E+00	2.8274E+00	3.1416E+00
R(M)										
2.5472E+00	1.065E+01	1.029E+01	9.615E+00	8.463E+00	6.647E+00	4.437E+00	2.622E+00	1.471E+00	7.477E-01	4.491E-01
2.8069E+00	3.503E+00	3.256E+00	2.756E+00	2.043E+00	1.778E+00	2.064E+00	1.400E+00	1.078E+00	5.889E-01	3.278E-01
3.0793E+00	5.995E-01	4.280E-01	8.409E-02	-3.479E-01	-6.942E-02	9.159E-01	1.195E+00	7.637E-01	4.146E-01	2.249E-01
3.9721E+00	-6.629E-02	-1.215E-01	-2.261E-01	-3.198E-01	-1.745E-01	1.747E-01	3.201E-01	2.267E-01	1.215E-01	6.105E-02
4.9783E+00	-1.107E-02	-2.301E-02	-4.772E-02	-7.082E-02	-3.909E-02	3.911E-02	7.089E-02	4.785E-02	2.303E-02	9.875E-03
6.0981E+00	-8.390E-04	-2.284E-03	-6.090E-03	-9.906E-03	-5.568E-03	5.570E-03	9.915E-03	6.112E-03	2.289E-03	5.631E-04
7.3313E+00	-2.139E-05	-4.516E-05	-2.133E-04	-5.562E-04	-3.821E-04	3.822E-04	5.564E-04	2.145E-04	4.734E-05	8.313E-06
8.6781E+00	-1.209E-07	-1.223E-07	-9.711E-07	-3.784E-06	-2.938E-06	2.938E-06	3.785E-06	9.772E-07	1.461E-07	1.786E-08
1.0138E+01	-1.323E-10	-5.616E-11	-8.077E-10	-4.249E-09	-3.517E-09	3.518E-09	4.249E-09	8.132E-10	6.874E-11	7.845E-12
1.1712E+01	-3.162E-14	-2.433E-15	-1.407E-13	-1.000E-12	-8.692E-13	8.692E-13	1.000E-12	1.417E-13	1.118E-14	7.067E-16
1.3399E+01	-1.638E-18	1.904E-19	-5.178E-18	-5.048E-17	-4.555E-17	4.555E-17	5.049E-17	5.218E-18	2.953E-19	1.327E-20
1.5200E+01	-1.870E-23	4.092E-24	-4.168E-23	-5.620E-22	-5.216E-22	5.217E-22	5.620E-22	4.201E-23	1.694E-24	5.376E-26
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

THETA(RAD)	0.
R(M)	
2.5472E+00	0.
2.8069E+00	0.
3.0793E+00	0.
3.9721E+00	0.
4.9783E+00	0.
6.0981E+00	0.
7.3313E+00	0.
8.6781E+00	0.
1.0138E+01	0.
1.1712E+01	0.
1.3399E+01	0.
1.5200E+01	0.
0.	0.

Figure 5 (cont.)

6. VARIABLE GLOSSARY

A glossary of DYNASPHERE variables and output headings is contained in this section. Definitions of input quantities are given in the input description section of this report, so many of those quantities are not found here. All output variables and headings essential to the usage of the code for "production" SGEMP calculations are defined in the glossary.

GLOSSARY OF DYNASPHERE VARIABLES AND OUTPUT HEADINGS

ASPHER	EMISSION AREA (M2)
CURRENTS	IN 2-D PRINT, ACTUALLY SHOULD BE CURRENT DENSITY (AMP/M2)
E	ELECTRIC FIELD (VOLT/M)
EMQ	TOTAL CHARGE TO BE EMITTED FROM EACH EMISSION ZONE OVER THE ENTIRE EMISSION CURRENT PULSE. THE SUM OF THESE VALUES SHOULD BE ROUGHLY EQUAL TO THE INTEGRAL OF THE EMISSION CURRENT DENSITY OVER TIME AND SPACE FOR THE ENTIRE PULSE. AT EACH EMISSION TIME STEP, A PARTICLE IS EMITTED FROM EACH ZONE WITH AN AMOUNT OF CHARGE EQUAL TO TE * EMQ (I), WHERE TE IS DEFINED BELOW.
ENERGY	EMISSION ELECTRON INITIAL ENERGIES (KEV).
ER	RADIAL ELECTRIC FIELD (VOLT/M). PLOTTED AT END OF RUN FOR VALUE ON INNER SPHERE AT THETA=0 VS. TIME.
ER(0,90DEG)	ER ON INNER SPHERE AT THETA=0 AND 90 DEGREE POSITIONS (OR CLOSEST TO THEM). (VOLT/M)
FGENE	QGENE/QINJEK. FRACTIONAL AMOUNT OF EMISSION CHARGE RETURNING TOWARD SPHERE AT EACH RADIAL ZONE (DIMENSIONLESS)
H	MAGNETIC FIELD (AMP/M)
ITIME	PARTICLE TIME STEP NUMBER
JNET	APPROXIMATE EXPRESSION FOR THE NET AVERAGE CURRENT DENSITY LEAVING THE INNER SPHERE. EQUALS NET CURRENT ONTO INNER SPHERE DIVIDED BY EMISSION AREA. AVERAGED JNET DESIGNATES JNET ALSO. EQUALS JNOW IN NON-SCL CASES. (AMP/CM2)
JNOW	EMISSION CURRENT DENSITY AT THIS TIME AVERAGED OVER EMISSION AREA. (AMP/CM2).
MAX. NO. OF PARTICLES UP TO THIS TIME	MAXIMUM VALUE OF NPART UP TO THIS TIME.
NA	NUMBER OF ANGULAR ZONES
NBACK	CUMULATIVE NUMBER OF PARTICLES RETURNING TO INNER SPHERE UP TO THIS TIME

NBANK	QUASI-STATIC, SINGLE SPHERE CALCULATIONS ONLY: TOTAL NUMBER OF PARTICLES IN STORAGE BANK FOR THOSE PARTICLES OUTSIDE REGION WHERE GREEN'S FUNCTION FOR FIELDS IS DEFINED. A RADIAL FORCE DUE TO NET CHARGE ON SPHERE PULLS THESE PARTICLES BACK TO THE REGION WHERE THEY CAN REENTER THE SPATIAL MESH AND AGAIN HAVE BOTH RADIAL AND AXIAL FIELDS CALCULATED FROM THE GREEN'S FUNCTION ACT ON THEM. THOSE PARTICLES WITH KINETIC ENERGY GREATER THAN SPHERE POTENTIAL ENERGY ESCAPE TO INFINITY.
NLEAVE	CUMULATIVE NUMBER OF PARTICLES WHICH HAVE LEFT SYSTEM UP TO THIS TIME BY STRIKING INNER OR OUTER BOUNDARY
NPART	NUMBER OF PARTICLES BEING FOLLOWED AT THIS TIME. INCLUDES THOSE IN THE BANK IN QUASI-STATIC CALCULATIONS.
NR	NUMBER OF RADIAL ZONES
NRET	QUASI-STATIC, SINGLE SPHERE CALCULATIONS ONLY: CUMULATIVE NUMBER OF PARTICLES RETURNING FROM STORAGE BANK UP TO THIS TIME (SEE NBANK)
PHI	DESIGNATES INNER SPHERE POTENTIAL RELATIVE TO OUTER SPHERE (VOLTS)
POTENTIAL	ELECTRIC POTENTIAL. (VOLTS)
Q_1	GENERALIZED COORDINATE CORRESPONDING TO RADIAL VARIABLE.
Q_2	GENERALIZED COORDINATE CORRESPONDING TO POLAR ANGULAR VARIABLE.
Q_3	GENERALIZED COORDINATE CORRESPONDING TO AZIMUTHAL ANGULAR VARIABLE.
QBACK	TOTAL PARTICLE CHARGE WHICH HAS STRUCK INNER SPHERE UP TO THIS TIME (COUL). ALSO USED TO DESIGNATE THE QGENE ARRAY, DEFINED BELOW.
QGENE	ARRAY OF NR VALUES GIVING AMOUNT OF CHARGE IN EACH RADIAL ZONE WHICH IS RETURNING TOWARD INNER SPHERE. (COUL)
QHERE	CHARGE EMITTED FROM EACH ANGULAR ZONE ON INNER SPHERE MINUS CHARGE RETURNED TO EACH ANGULAR ZONE ON SURFACE OF INNER SPHERE. RETURN CHARGE IS FROM PARTICLES ONLY, NOT DUE TO SURFACE CURRENT FLOW. (COUL)
QIN	NET CHARGE OUT TO A GIVEN RADIUS INCLUDING THE NET CHARGE ON THE INNER SPHERE AND ALL THE ANGULAR ZONES. NOT CALCULATED PROPERLY AT PRESENT. (COUL).
QINJEK	TOTAL CHARGE EMITTED UP TO THIS TIME (COUL)
QIN/QS	QIN/QNET. GIVES NET CHARGE OUT TO EACH RADIAL POSITION AS FRACTION OF INNER SPHERE NET CHARGE. (DIMENSIONLESS) NOT CALCULATED PROPERLY AT PRESENT.
QLEAVE	TOTAL CHARGE STRIKING SPHERICAL SURFACES UP TO THIS TIME (COUL). INCLUDES CHARGE ESCAPING PAST RMAX IN SINGLE SPHERE, QUASI-STATIC CASES.
QNET	NET CHARGE ON INNER SPHERE. EQUALS QINJEK - QBACK. (COUL). ALSO USED AS TITLE OF QHERE ARRAY.
R	RADIAL ZONE BOUNDARIES OR CENTERS, DEPENDING ON WHICH FIELD, CURRENT, OR CHARGE QUANTITY IS BEING PRINTED OUT. SEE TABLE . ALSO USED IN THE MINI-PRINT TO DESIGNATE RADIAL POSITIONS OF THE FIRST AND LAST 5 PARTICLES PRESENTLY BEING FOLLOWED. ALSO USED IN EMISSION PARTICLE CHARACTERISTICS PRINT OUT TO INDICATE INITIAL RADIAL POSITIONS OF THE PARTICLES.
RMAX	OUTER RADIAL BOUNDARY OF THE CALCULATION. CAN BE A RADIAL POSITION IN FREE SPACE IN QUASI-STATIC CASES. (M)

SCUR	SURFACE CURRENTS FLOWING ON INNER SPHERE AT EACH ANGULAR POSITION. OBTAINED FROM MAGNETIC FIELD JUST OUTSIDE SPHERE WHICH IS EVALUATED AT ZONE CENTERS IN EACH COORDINATE. (AMPS)
SPEED	EMISSION ELECTRON INITIAL SPEEDS (KEV).
SURFACE CHARGE DENSITY	SURFACE CHARGE ON INNER AND OUTER SPHERES IN EACH ZONE ON THE SURFACES. INNER SPHERE ALWAYS PRINTED, OUTER SPHERE DEPENDS ON IOPT(30), THE PRODUCTION PRINT FLAG, OBTAINED FROM THE NORMAL ELECTRIC FIELD NEAR THE SURFACES. THE SUM OF THE VALUES ON THE INNER SPHERE SHOULD AGREE ROUGHLY WITH QNET, THE NET CHARGE ON THE INNER SPHERE OBTAINED FROM THE PARTICLE MOTION. THE Q1 VALUE APPEARS TO BE IN ERROR FOR THIS PARTICULAR PRINTOUT QUANTITY. (COUL).
SURFACE CURRENT	CURRENT DENSITIES FLOWING ON INNER AND OUTER SPHERES. INNER SPHERE ALWAYS PRINTED, OUTER SPHERE DEPENDS ON IOPT(30), THE PRODUCTION PRINT FLAG. THESE CURRENT DENSITIES ARE OBTAINED FROM THE MAGNETIC FIELD FIRST NON-ZERO VALUE NEAR THE SPHERICAL SURFACES. THE VALUE OF Q1 APPEARS TO BE IN ERROR FOR THIS PARTICULAR PRINTOUT QUANTITY. (AMP/M) PLOTTED WITH UNITS OF AMPS AT END OF RUN.
SURFCUR(45, 90,135 DEG)	SURFACE CURRENTS ON INNER SPHERE CLOSEST TO THE 45, 90, AND 135 DEGREE POSITIONS, RESPECTIVELY. SEE SCUR. (AMPS) THE EXACT ANGULAR POSITIONS CLOSEST TO THE 45, 90 AND 135 DEGREE LOCATIONS ARE PRINTED OUT IN THE SURFACE CURRENT TIME HISTORY PRINTOUT NEAR THE LAST PAGE OF THE PRINTOUT.
T	TIME (NSEC)
TE	FRACTION OF THE TOTAL EMISSION CURRENT PULSE AREA OCCUPIED BY THE CURRENT PULSE HEIGHT TIMES THE PARTICLE TIME STEP. (DIMENSIONLESS)
THETA	POLAR ANGLE (RADIANS)
VR	RADIAL VELOCITY (M/SEC)
VTHETA	POLAR VELOCITY (M/SEC)

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